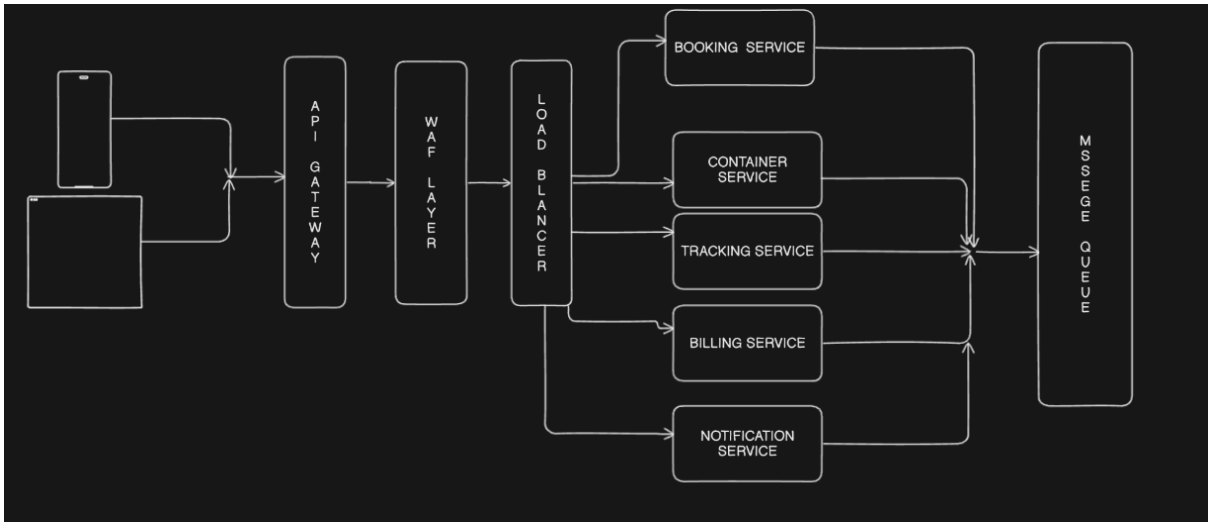
CONTAINER SHIPPING SYSTEM LLD

Sr No.	Description
1.	System Architecture Overview
2.	Class Diagram
3.	Component Diagrams
4.	Database Schema
5.	API Specification
6.	Design Pattern Applied
7.	Solid Principles Implementation
8.	Error Handling Strategy
9.	Performance Considerations

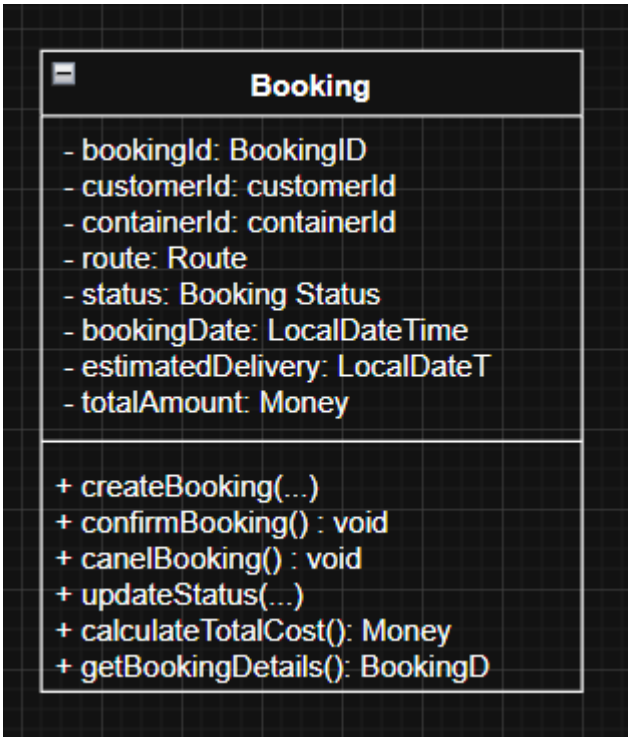
1. SYSTEM ARCHITECTURE OVERVIEW



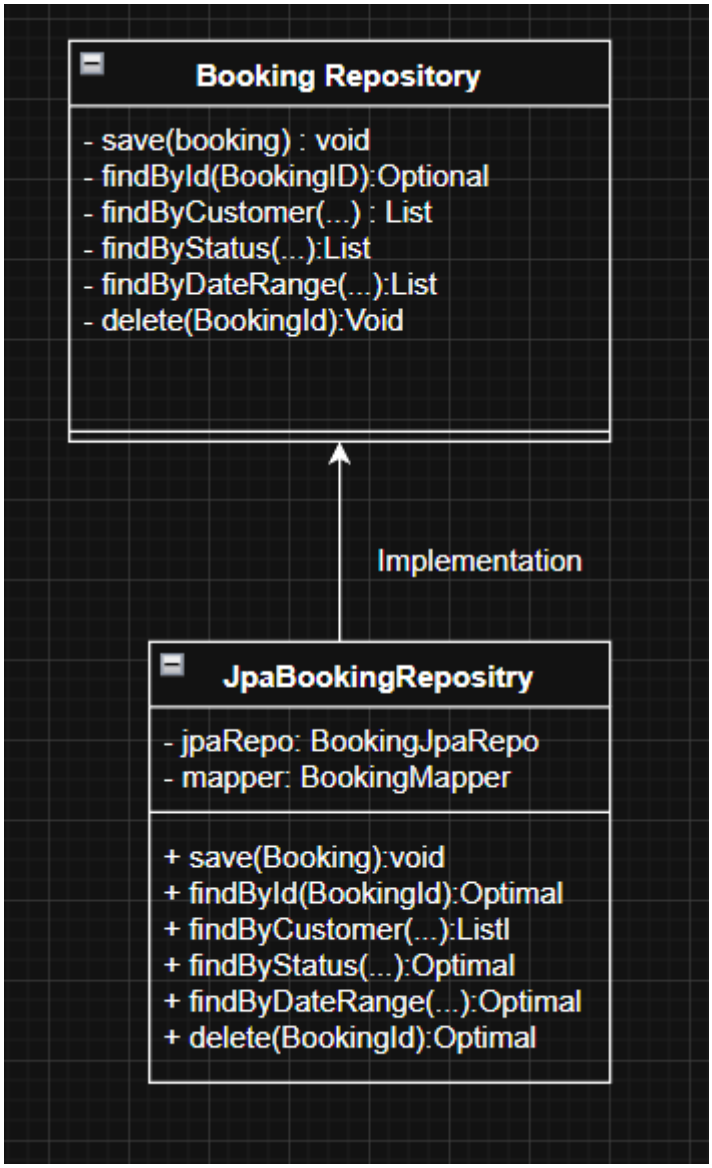
---

2. Class Diagram

2.1 Core Domain Classes

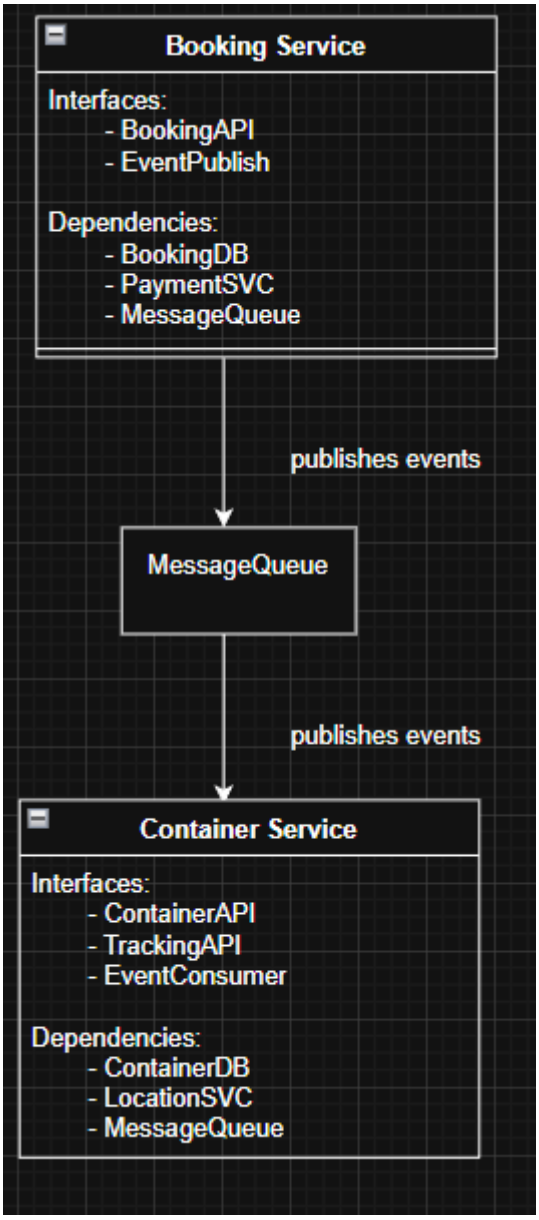


2. 3: Repository Pattern Implementation

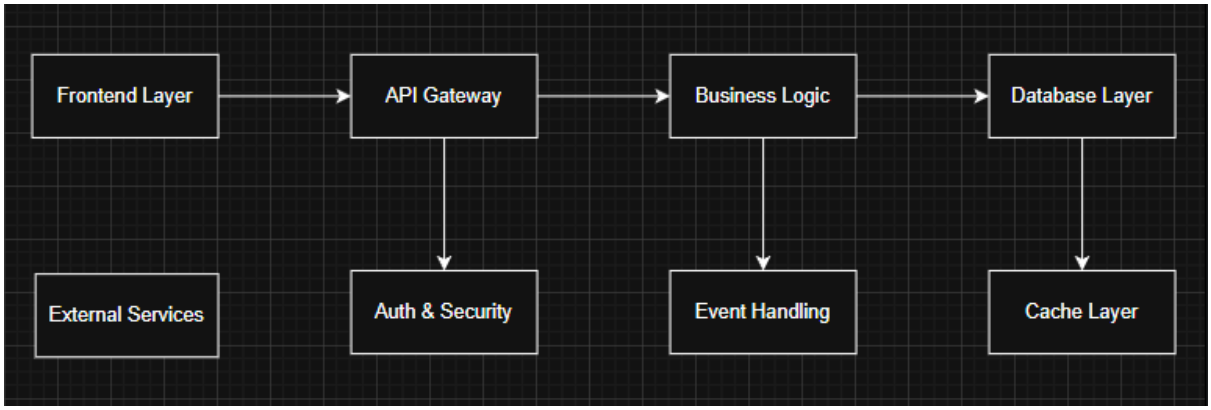


3.Component Diagrams

3.1 Microservices Architecture:



3.2 Data Flow Architecture:



---

4. Database Schema

4.1 Core Tables Structure

Bookings Table:

Table: Booking

Column Name	Data Type	Constraints	Description
Booking_ID	VARCHAR(50)	PRIMARY KEY	Unique ID
Customer_id	VARCHAR(50)	Not Null	Customer FK
Original_port	VARCHAR(50)	Not Null	Origin Cost
Dest_port	VARCHAR(50)	Not Null	Dest Code
Status	VARCHAR(50)	Not Null	Enum status
booking_date	TIMESTAMP	Not Null	Created AT
estimeted_del	TIMESTAMP	Null	ETA
total_amount	DECIMAL(10,2)	Not Null	Total Cost
created_AT	TIMESTAMP	DEFAULT NOW	Created
Updated_AT	TIMESTAMP	ON UPDATE	Modified

Indexes: - idx_customer_id (customer_id)

- idx_booking_date (booking_date)

- idx_status (status)

Containers Table:

Column Name	Data Type	Constraints	Description
Customer_id	VARCHAR(50)	PRIMARY KEY	Unique ID
Type	VARCHAR(50)	Not Null	Type enum
Status	VARCHAR(50)	Not Null	Status Enum
Current_lat	DECIMAL(9,6)	Null	Lastitude

Current_lng	DECIMAL(9,6)	Null	Logitude
Weight	DECIMAL(9,6)	DEFAULT 0	Weight
Contents	TEXT	Null	Description
Last_updated	TIMESTAMP	DEFAULT NOW	Last Updated
Created_at	TIMESTAMP	DEFAULT NOW	Created

Booking-Container Mapping:

Column Name	Data Type	Constraints	Description
id	BIGINT	PRIMARY KEY	Auto Inc
Booking_ID	VARCHAR(50)	FK, NOT NULL	Booking Ref
Container_id	VARCHAR(50)	FK, NOT NULL	Container
Assigned_at	DECIMAL(9,6)	Default Now	Assignment

4.2 Entity Relationships

Customer ||————————o{ Booking

Booking }o————————o{ Container

Container ||————————o{ LocationHistory

Booking ||————————|| Payment

Booking ||————————o{ Notification

Port ||————————o{ Route

Route ||————————o{ Booking

---

5. API Specifications

5.1 Booking API Endpoints:

Create Booking:

POST /api/v1/bookings

Content-Type: application/json

Authorization: Bearer {token}

Request Body:

```
{
  "customerId": "string",
  "originPort": "string",
  "destinationPort": "string",
```

```
  "containerRequirements": [
    {
      "type": "STANDARD_20FT",
      "quantity": 2,
      "contents": "string"
    }
  ],
  "preferredDate": "2024-01-15T10:00:00Z",
  "specialRequirements": "string"
}
```


Response (201 Created):


```
{
  "bookingId": "BK_2024_001234",
  "status": "PENDING",
  "estimatedCost": 1250.00,
  "estimatedDelivery": "2024-01-25T14:00:00Z",
  "message": "Booking created successfully"
}
```


Error Response (400 Bad Request):


```
{
  "error": "INSUFFICIENT_CONTAINERS",
  "message": "Not enough containers available",
  "details": {
    "requested": 5,
    "available": 3
  }
}
```


Get Booking Details:

GET /api/v1/bookings/{bookingId}

Authorization: Bearer {token}

Response (200 OK):

```
{
 "bookingId": "BK_2024_001234",
 "customerId": "CUST_001",
 "status": "CONFIRMED",
 "route": {
  "origin": "MUMBAI",
  "destination": "DUBAI",
  "distance": 1200.5
 },
 "containers": [
  {
   "containerId": "CONT_123456",
   "type": "STANDARD_20FT",
   "currentStatus": "IN_TRANSIT",
   "currentLocation": {
    "latitude": 19.0760,
    "longitude": 72.8777,
    "timestamp": "2024-01-20T08:30:00Z"
   }
  }
 ],
 "totalAmount": 1250.00,
 "paymentStatus": "COMPLETED"
}
```


5.2 Container Tracking API:

Track Container:

GET /api/v1/containers/{containerId}/track

Authorization: Bearer {token}

Response (200 OK):

```
{
 "containerId": "CONT_123456",
 "currentLocation": {
  "latitude": 19.0760,
  "longitude": 72.8777,
  "address": "Mumbai Port, India",
  "timestamp": "2024-01-20T08:30:00Z"
 },
 "status": "IN_TRANSIT",
 "locationHistory": [
  {
   "latitude": 18.9220,
   "longitude": 72.8347,
   "address": "Departure Port",
   "timestamp": "2024-01-15T10:00:00Z"
  }
 ],
 "estimatedArrival": "2024-01-25T14:00:00Z"
}
```


---

6. Design Patterns Applied:

6.1 Factory Pattern

ContainerFactory

├─ createStandardContainer()

├─ createRefrigeratedContainer()

├─ createHighCubeContainer()

└─ createTankContainer()

Usage Context:

- Container creation based on booking requirements

- Centralized container instantiation logic

- Type-specific initialization handling

6.2 Strategy Pattern:

PricingStrategy Interface

├─ DistanceBasedPricing

├─ WeightBasedPricing

├─ VolumeBasedPricing

└─ PremiumServicePricing

Context: BookingService

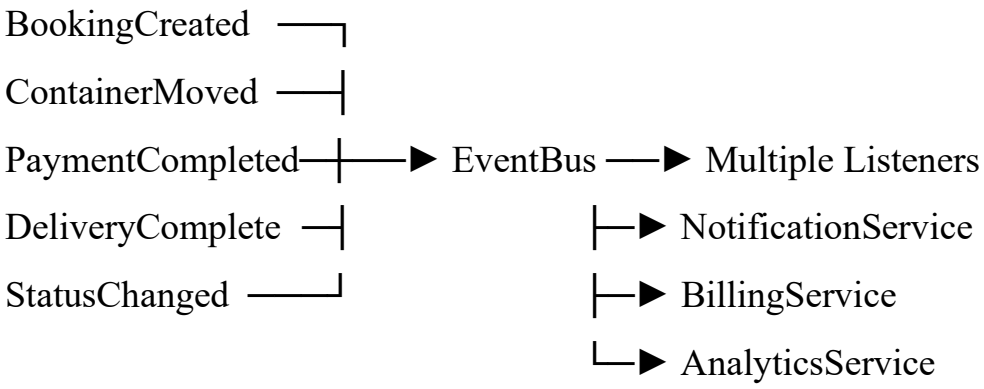
- Flexible pricing calculation

- Easy addition of new pricing models

- Runtime strategy selection

6.3 Observer Pattern:

Event Publishing System:



6.4 Repository Pattern

Repository Abstraction Layer:

Domain Model ←——→ Repository Interface ←——→ Data Access Implementation

Booking ←——→ BookingRepository ←——→ JpaBookingRepository

Container ←——→ ContainerRepository ←——→ JpaContainerRepository

---

7. SOLID Principles Implementation:

7.1 Single Responsibility Principle

- BookingService: Only handles booking operations

- ContainerService: Only manages container lifecycle
- PaymentService: Only processes payments
- NotificationService: Only sends notifications

7.2 Open/Closed Principle

- PricingStrategy: Open for extension (new pricing models), closed for modification
- NotificationChannel: Can add new channels without changing existing code
- ContainerType: Extensible for new container types

7.3 Liskov Substitution Principle

- Container hierarchy: All container types can be used interchangeably
- Repository implementations: Any repository implementation works with service layer

7.4 Interface Segregation Principle

- Separate interfaces for different concerns:
    - ContainerTracker for location updates
    - ContainerInventory for availability management
    - ContainerMaintenance for maintenance operations

7.5 Dependency Inversion Principle

- High-level modules (Services) depend on abstractions (Interfaces)
- Low-level modules (Repositories) implement the abstractions
- Dependency injection used throughout the system

---

8. Error Handling Strategy:

8.1 Exception Hierarchy:

```
├── BookingException
│   ├── BookingNotFoundException
│   ├── BookingAlreadyConfirmedException
│   └── InsufficientContainersException
├── ContainerException
│   ├── ContainerNotFoundException
│   ├── ContainerNotAvailableException
│   └── InvalidLocationException
```

└─ PaymentException

├─ PaymentFailedException

└─ InsufficientFundsException

8.2 Global Error Handling:

HTTP Status Code Mapping:

400 Bad Request ←── Validation Errors

401 Unauthorized ←── Authentication Issues

404 Not Found ←── Resource Not Found

409 Conflict ←── Business Rule Violations

422 Unprocessable ←── Business Logic Errors

500 Internal Error ←── System Errors

---

9. Performance Considerations

9.1 Caching Strategy

- Redis Cache: Frequently accessed booking details
- Application Cache: Container availability data
- CDN: Static content and images

9.2 Database Optimization

- Read Replicas: For tracking and reporting queries
- Indexing: On frequently queried columns
- Partitioning: Large tables by date/region

9.3 Monitoring and Metrics

- Response Time: API endpoint performance
- Throughput: Requests per second
- Error Rate: Failed requests percentage
- Resource Usage: CPU, Memory, Database connections